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Cenopopulations of *Adonis wolgensis* Stev. in the conditions of Northern Kazakhstan

The article presents the study results on the cenopopulations of *Adonis wolgensis* in Northern Kazakhstan (2019–2021). The materials are obtained as a result of field research; literary data are considered. Based on detailed route studies, the structure of cenopopulations is given. Nine cenopopulations located in the Kostanay region are studied. Populations of *A. wolgensis* occupy areas from 300 to 1000 m². The largest total projective cover is noted in forest clearings and along the outskirts of forests. The proportion of *A. wolgensis* in the total projective cover there is 1–5 %. The studied cenopopulations are characterized by contagious and random types of distribution of individuals in space; a uniform (regular) type is not recorded. An assessment of the vitality type of cenopopulations shows that five of the studied cenopopulations have a normal vitality type and four flourishing ones. Cenopopulations that are in an oppressed, depressed, and infertile states are not found.

Keywords: *Adonis wolgensis* Stev., rare plants, cenopopulation, Northern Kazakhstan, total projective cover.

Introduction

Conservation of the biodiversity of animal and plant species, communities and ecosystems is an integral part of the Concept of Humanity's Transition to the Principles of Sustainable Development. Within the framework of this problem, it is recognized that the protection of life on Earth is not a narrow task of certain groups and circles; it is the task of all mankind and, at the same time, a condition for its survival on the planet [1].

Adonis wolgensis Stev. listed in the Red Book of Kazakhstan (category III "Reducing species") [2]. A.P. Poshkurlat (2000) provides information about the presence of *A. wolgensis* in the mountains of Karkaraly, Ortau, in the southern part of the Mugodzhar Mountains, near Lake Zaisan on Tarbagatai. A.P. Gamayunova (1961) cites *A. wolgensis* for the Spurs of the Common Syrt, Tobolsk-Ishimsky, Semipalatinsk upland, Caspian floristic regions, Western and Eastern small hills. Yu.A. Kotukhov (2005) cites it for the Western and Karbinsky Altai. Z.V. Karamysheva and E.I. Rachkovskaya (1973) cite it for the entire steppe part of the Kazakh uplands [3].

Experimental

Study of cenopopulations of *A. wolgensis* was held on the territory of Northern Kazakhstan in 2019–2021. To study cenopopulations (CP), areas with a high density of flowering individuals were selected. With the help of GPS, the boundaries of the CP were determined. A floristic description of the CP was carried out, indicating the number of species, total and partial projective cover (TPC, %).

9 cenopopulations of *A. wolgensis* located in the Kostanay region were studied. The herbarium material is stored at Department of Biology and Chemistry of the A. Baitursynov Kostanay Regional University.

Results and Discussion

A. wolgensis is a short-rod herbaceous polycarpic plant, in Northern Kazakhstan it is represented by three morphotypes: steppe, meadow-steppe, and forest, which have significant morphological differences in the height of the shoots and the shape of the leaf blades [4].

9 cenopopulations of *A. wolgensis* were studied on the territory of the Auliekol district of the Kostanay region.

CP-1. Kostanay region district of Amankaragai village, Amankaragai forestry, quarter 39, N 52.412135, E 64.041553. Glade of pine-birch forest. Population area 900 m², TPC — 100 %, *A. wolgensis* — 1,0 %. Population density 21 psc/100 m². Number — 189 individuals. The type of distribution of individuals in space is contagious. The vitality type of the population is normal (according to the Brown-Blanque scale).

Species that make up the coenotic environment: *Pinus sylvestris* L., *Betula pendula* Roth, *Populus tremula* L., *Pulsatilla uralensis* (Zämelis) Tzvelev, *Gypsophila paniculata* L., *Otites wolgensis* (Hornem.) Grossh., *Rumex acetosa* L., *Limonium gmelinii* (Willd.) Kuntze, *Fragaria viridis* (Duchesne) Weston, *Potentilla arenaria* Borkh., *Rosa majalis* Herrm., *Spiraea hypericifolia* L., *Oenothera biennis* L., *Artemisia laciniata* Willd., *Thymus marschallianus* Willd., *Allium tulipifolium* Ledeb., *Allium angulosum* L., *Carex caryophylla* Latourr., *Agropyron pectinatum* (M. Bieb.) Beauv., *Plantago media* L., *Cichorium intybus* L., *Iris pumila* L., *Festuca valesiaca* Gaudin., *Tulipa biebersteiniana* Schult. & Schult.f.

CP-2. Kostanay region, Amankaragai forestry, quarter 36, N 52.412893, E 63.981660. Glade in a pine forest. Population area 1000 m², TPC — 100 %, *A. wolgensis* — 4,0 %. Population density 37 pcs/100 m². Number — 370 individuals. The type of distribution of individuals in space is random. The vitality type of the population is prosperous. Species that make up the coenotic environment: *Pinus sylvestris* L., *Pulsatilla uralensis* (Zämelis) Tzvelev, *Otites wolgensis* (Hornem.) Grossh., *Rumex acetosa* L., *Fragaria viridis* (Duchesne) Weston, *Potentilla arenaria* Borkh., *Spiraea hypericifolia* L., *Artemisia laciniata* Willd., *Thymus marschallianus* Willd., *Allium tulipifolium* Ledeb., *Allium angulosum* L., *Agropyron cristatum* (L.) Beauv., *Plantago media* L., *Iris pumila* L., *Festuca valesiaca* Gaudin., *Glycyrrhiza uralensis* Fisch., *Achillea asiatica* Serg., *Artemisia campestris* L., *Centaurea scabiosa* L., *Hieracium umbellatum* L., *Onosma simplicissima* L., *Veronica longifolia* L., *Gagea fedtschenkoana* Pascher, *Carex ericetorum* Pollich.

CP-3. Kostanay region district of Zhilgorodok village, Amankaragai forestry, 121 quarter, N 52.380174, E 64.063696. Edge of a birch forest. Population area 800 m², TPC — 100 %, *A. wolgensis* — 2,0 %. Population density 34 pcs/100 m². Number — 272 individuals. The type of distribution of individuals in space is contagious. The vitality type of the population is prosperous. Species that make up the coenotic environment: *Betula pendula* Roth, *Pulsatilla uralensis* (Zämelis) Tzvelev, *Rumex acetosa* L., *Fragaria viridis* (Duchesne) Weston, *Potentilla arenaria* Borkh., *Spiraea hypericifolia* L., *Artemisia absinthium* L., *Artemisia frigida* Willd., *Agropyron cristatum* (L.) Beauv., *Plantago media* L., *Festuca valesiaca* Gaudin., *Achillea asiatica* Serg., *Veronica longifolia* L., *Spiraea hypericifolia* L., *Sedum telephium* L., *Rosa acicularis* Lindl., *Rosa majalis* Herrm., *Melilotus officinalis* (L.) Pall., *Valeriana tuberosa* L., *Taraxacum officinale* F.H. Wigg., *Tulipa biebersteiniana* Schult. & Schult. f., *Plantago major* L., *Capsella bursa-pastoris* (L.) Medikus, *Nonea rossica* Stev., *Achillea millefolium* L., *Antennaria dioica* (L.) Gaertn., *Elytrigia repens* (L.) Nevski, *Psephellus sibiricus* (L.) Wagenitz.

CP-4. Kostanay region, Novonezhinsk forestry, quarter 149, N 52.435072, E 63.968779, *h* = 213 m above sea level. Shrubbed edge of a pine forest. Population area 800 m², TPC — 100 %, *A. wolgensis* — 3,0 %. Population density 26 pcs/100 m². Number — 208 individuals. The type of distribution of individuals in space is random. The vitality type of the population is normal. Species that make up the coenotic environment: *Pinus sylvestris* L., *Pulsatilla uralensis* (Zämelis) Tzvelev, *Otites wolgensis* (Hornem.) Grossh., *Rumex acetosa* L., *Spiraea hypericifolia* L., *Agropyron pectinatum* (M. Bieb.) Beauv., *Iris pumila* L., *Festuca valesiaca* Gaudin., *Glycyrrhiza uralensis* Fisch., *Achillea asiatica* Serg., *Veronica spicata* L., *Allium angulosum* L., *Elytrigia repens* (L.) Nevski.

CP-5. Kostanay region district of the village of Ozerny, Novonezhinskoye forestry, quarter 37, N 52.493945, E 64.080103, *h* = 213 m above sea level. Glade in a pine-birch forest. Population area 500 m², TPC — 100 %, *A. wolgensis* — 1,0 %. Population density 36 pcs/100 m². Number — 180 individuals. The type of distribution of individuals in space is random. The vitality type of the population is normal. Species that make up the coenotic environment: *Pinus sylvestris* L., *Betula pendula* Roth, *Artemisia campestris* L., *Pulsatilla uralensis* (Zämelis) Tzvelev, *Otites wolgensis* (Hornem.) Grossh., *Spiraea hypericifolia* L., *Iris pumila* L., *Festuca valesiaca* Gaudin., *Achillea asiatica* Serg., *Elytrigia repens* (L.) Nevski., *Echinops sphaerocephalus* L., *Potentilla arenaria* Borkh., *Gypsophila paniculata* L., *Medicago falcata* L., *Xanthoselinum alsaticum* (L.) Schur, *Carex supina* Willd. ex Wahlenb., *Jacobaea erucifolia* (L.) Gaertn., Mey. et Scherb.

CP-6. Kostanay region, Kalinin forestry, quarter 92, N52.427995, E 64.085151. Depression in a pine forest overgrown with birches. Population area 600 m², TPC — 30 %, *A. wolgensis* — 60 %. Population density 40 pcs/100 m². Number — 240 individuals. The type of distribution of individuals in space is random. The vitality type of the population is prosperous. Species that make up the coenotic environment: *Betula pendula* Roth, *Tulipa biebersteiniana* Schult. & Schult. f., *Poa pratensis* L., *Festuca valesiaca* Gaudin, *Equisetum hyemale* L.

CP-7. Kostanay region, Kalinin forestry, quarter 69, N 52.454605, E 64.376370. Outskirts of a pine forest. Population area 300 m², TPC — 90 %, *A. wolgensis* — 1,0 %. Population density 20 pcs/100 m². Num-

ber — 60 individuals. The type of distribution of individuals in space is contagious. The vitality type of the population is prosperous. Species that make up the coenotic environment: *Pinus sylvestris* L., *Gypsophila paniculata* L., *Filipendula stepposa* Juz., *Spiraea hypericifolia* L., *Astragalus testiculatus* Pall., *Achillea asiatica* Serg., *Artemisia campestris* L., *Echinops sphaerocephalus* L., *Agropyron pectinatum* (M. Bieb.) Beauv., *Bromopsis inermis* (Leyss.) Holub, *Phleum phleoides* (L.) H. Karst., *Stipa pennata* L.

CP-8. Kostanay region, Basaman forestry, N 52.389946, E 63.803410. Glade in a pine forest. Population area 800 m², TPC — 100 %, *A. wolgensis* — 5,0 %. Population density 33 pcs/100 m². Number — 264 individuals. The type of distribution of individuals in space is contagious. The vitality type of the population is normal. Species that make up the coenotic environment: *Pinus sylvestris* L., *Rumex acetosa* L., *Fragaria viridis* (Duchesne) Weston, *Spiraea hypericifolia* L., *Allium angulosum* L., *Agropyron cristatum* (L.) Beauv., *Plantago media* L., *Iris pumila* L., *Festuca valesiaca* Gaudin., *Achillea asiatica* Serg., *Limonium gmelinii* (Willd.) Kuntze, *Rosa majalis* Herrm., *Glycyrrhiza uralensis* Fisch., *Veronica incana* L.

CP-9. Kostanay region, Ubagan forestry, quarter 143, N 52.294367, E 64.542288. Sparse pine planting. Population area 400 m², TPC — 20 %, *A. wolgensis* — 50 %. Population density 25 pcs/100 m². Number — 100 individuals. The type of distribution of individuals in space is contagious. The vitality type of the population is normal. Species that make up the coenotic environment: *Pinus sylvestris* L., *Poa pratensis* L., *Agropyron cristatum* (L.) Beauv.

Populations of *A. wolgensis* occupy areas from 300 (CP-7) to 1000 m² (CP-2). The largest total projective cover was noted in forest clearings and along the outskirts of forests 90–100 %. The proportion of *A. wolgensis* in the total projective cover here is 1–5 % (CP-1, CP-2, CP-3, CP-4, CP-5, CP-7, CP-8). In other habitats (CP-6 and CP-9), the total projective cover is 30 and 20 %, respectively. The share of *A. wolgensis* in the total projective cover of CP-6 and CP-9 is 60 and 50 %, respectively, which are the largest proportions of *A. wolgensis* in the total projective cover. However, such a large percentage of the share of *A. wolgensis* in the total projective cover is due not to the significance of its growth in this area and a large number of individuals, but in general to a small amount of vegetation in these areas, represented by 3–5 plant species, and a low percentage of the total projective cover. This effect is probably caused by the high shading of these areas and the soil cover here with a thick layer of dead leaves and needles (CP-6 — a depression in a pine forest overgrown with birches, CP-9 — a sparse pine plantation).

Conclusions

The highest density of individuals was noted in CP-6 (40 individuals per 100 m²), CP-2 (37 pcs/100 m²), CP-5 (36 pcs/100 m²), the lowest — in CP-1 (21 pcs/100 m²), CPU-7 (20 pcs/100 m²). The number of individuals varies from 370 (CP-2) to 60 (CP-7).

The studied cenopopulations are characterized by contagious (CP-1, CP-3, CP-7, CP-8, CP-9) and random (CP-2, CP-4, CP-5, CP-6) types of distribution of individuals in space, the uniform (regular) type is not fixed at all.

The assessment of the vitality type of cenopopulations on the comparative scales of the vital state of plants (on the Brown-Blanque scale) shows that the studied cenopopulations have normal vitality (CP-1, CP-4, CP-5, CP-8, CP-9) and prosperous types (CP-2, CP-3, CP-6, CP-7). Cenopopulations that are in an oppressed, depressed, and non-fruitful states were not found.

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Солтүсті Қазақстан жағдайындағы *Adonis wolgensis* Stev. ценопопуляциясының құрылымы

Мақалада Солтүстік Қазақстандағы *Adonis wolgensis* ценопопуляцияларын зерттеу нәтижелері берілген (2019–2021 жж.). Материалдар далалық зерттеулер нәтижесінде алынған, әдеби мәліметтер ескерілген. Егжей-тегжейлі бағыттық зерттеулер негізінде ценопопуляциялардың жас құрылымы келтірілген. Ақмола, Павлодар, Қостанай облыстарында орналасқан сегіз ценопопуляция зерттелді. *A. wolgensis* қысқа-өзекті шөпті поликарпик, ал Солтүстік Қазақстандағы *A. wolgensis* ценопопуляциясы негізгі үш мекендейтін жерге: дала қоғамдастықтары, шалғынды-дала, орманды деп топтастырылған. *A. wolgensis* ценопопуляциясын шығыста Екібастұздан, батыста Қостанай облысына дейін ендік бағытта зерттеу барысында дала экотоптарындағы қалпына келтіру индексі өте жоғары екенін анықталды. Қалған ценопопуляция, ол бірліктен әлдеқайда аз. Әсіресе, орманды жерлерде аз кездеседі. Жас жағдайының спектрі бойынша көптеген ценопопуляциялар қалыпты сипатқа ие және піскендер қатарына жатады. Бұл ценопопуляциясының құрылымына экологиялық және антропогендік факторлардың теріс әсерінің жоқтығын растайды және популяциялардың жаңартылуы мен сақталуын қамтамасыз етеді.

Кілт сөздер: *Adonis wolgensis* Stev., сирек өсімдіктер, ценопопуляция, Солтүстік Қазақстан, жалпы проекциялық жамылғы.

Г.Ж. Сұлтанғазина, М.Ю. Стешенко, Ю.О. Новак

Ценопопуляции *Adonis wolgensis* Stev. в условиях Северного Казахстана

В статье приведены результаты изучения ценопопуляций *Adonis wolgensis* в Северном Казахстане (2019–2020 гг.). Материалы получены в результате полевых исследований, учтены литературные данные. На основании детально-маршрутных исследований приведена структура ценопопуляций. Изучено девять ценопопуляций, расположенных в Костанайской области. Популяции *A. wolgensis* занимают площадь от 300 до 1000 м². Наибольшее общее проективное покрытие отмечено на лесных полянах и по окраинам лесов. Доля *A. wolgensis* в общем проективном покрытии здесь составляет 1–5 %. Изученным ценопопуляциям свойственны контактный и случайный типы распределения особей в пространстве, не зафиксирован равномерный (регулярный) тип. Оценка виталитетного типа ценопопуляций показала, что пять изученных ценопопуляций имеют нормальный виталитетный тип и четыре процветающих. Ценопопуляций, находящихся в очень угнетенном, угнетенном состояниях и неплодоносящих, не обнаружено.

Ключевые слова: *Adonis wolgensis* Stev., редкие растения, ценопопуляция, Северный Казахстан, общее проективное покрытие.

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